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ENTER, NEW COTTON PRODUCTS 1,2/

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It is always a pleasure to address a group like yours, which has so much in common with my own agency, the Southern Regional Research Laboratory of the U. S. Department of Agricultura. Among other things, we are both interested in the future of cotton and cottonseed -- and that is what I want to talk about today.

COTTON LINT

Until very recently, cotton had an unchallenged place in the textile market. It was supreme -- its position so well established that many outlets were taken for granted.

In fact, the market for cotton was a little like the lovable old donkey that belonged to a certain village. According to the story, this donkey wandered around wherever he pleased. Everybody spoke to him and petted him, but beyond that nobody paid much attention to him. They simply took him for granted. One day, the donkey was missing; and, as usually happens when something is taken for granted, he became very important when he was gone. The children looked for him, but could not find him. The women stopped their housework and went out to look for him. They couldn't find him either. The men left their fields and searched for him. He was not to be found. Finally, a wise old man volunteered to find him. The villagers were skeptical, but the old man wandered off and soon came back leading the donkey.

"Where did you find him?" the villagers wanted to know.

"Oh," replied the old man," I just said to myself: If I were a donkey, where would I go? And I looked there -- and there he was!"

Cotton's Competition

Now, the market for cotton hasn't completely disappeared -- as the donkey did. Cotton is still our most used textile material, but its supremacy

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1/ Report of a study in which certain phases were carried on under the Research and Marketing Act of 1946.

2/ Presented before the Fourth Annual Meeting of the Texas Chemurgic Council, Houston, Texas, March 5, 1949. Also, for presentation, under the title "New Cotton Products Through Chemistry" at the Tenth Annual Meeting, Agricultural Council of Arkansas, Memphis, Tennessee, March 28, 1949.

3/ One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

has been threatened by competing materials like rayon and paper in recent years. Like the villagers, we have become alarmed and are searching for ways to keep cotton's present outlets and to increase its usefulness. Much has been said and done about this problem by many different groups. Great as the contributions of these various groups have been, the mounting problems have increased the task ahead, and more and more the job is being turned over to the research chemist to see what he can do.

The chemist, like the wise old man in the story, has asked himself the question: Where would I go if I were the market for cotton? In other words, if I were a consumer and stopped buying cotton materials, what would I buy instead -- and why? Naturally, I'd want the most I could get for my money in terms of quality. If another material gave me this, I'd be likely to buy it instead of cotton. However, if cotton could be improved so that it always was the best product for my money, I'd buy cotton.

So, reasoned the chemist, the way to keep cotton's market supreme is to enhance the many excellent properties of cotton fiber and to find ways of modifying cotton to make it more attractive for specific uses.

The Chemical Make-Up of Cotton

To do this the chemist must think of cotton, not only as fiber or yarn or cloth, but also in terms of its chemical make-up. Since cotton is 90 percent cellulose, the scientist's conception of cotton is much the same as his conception of cellulose. The basic chemical unit of pure cellulose is known to be composed of specific amounts of carbon, hydrogen, and oxygen, arranged in a definite pattern with relation to each other.

Cellulose is a complex substance composed of many of these chemical units linked together like a chain. A single cotton fiber consists of layers of cellulose deposited around a central canal, with a ring for each day of growth, just as a tree has a ring for each year of growth. Differences in mechanical build-up of the cellulose layers in the fiber are generally given as the reason for variations in fiber properties. While this would seem to make the scientist's job more complicated, research during recent years indicates that it may be possible to take advantage of these differences in fiber properties in the development of new and improved cotton products.

Possibilities of Modification

I think it is apparent to all of us, however, that the variations in cotton fiber provided by nature are insufficient and that chemical treatments which alter or add to the basic structure of cellulose are required in some cases in developing cotton products with improved qualities.

The idea of chemical treatment is not new. In mentioning it here, I merely want to illustrate and emphasize the direction research is taking in attacking the problem of cotton utilization at our Laboratory in New Orleans and at other cotton research laboratories.

Research on the chemical modification of cotton to make it more attractive for specific products made significant progress during 1948, and I think the year's achievements provide the basis for many new cotton products. If any members of the Cotton Research Committee of Texas, the Textile Research Institute at Princeton, the Institute of Textile Technology at Charlottesville, the National Cotton Council, the Quartermaster Corps of the Army, or other agencies actively engaged in cotton utilization research are present, I am sure they will agree with me.

Aminization

Here is one example of chemical modification. It is a well known fact that even though cotton fabrics are available in a variety of colors, all dyes cannot be satisfactorily applied to cotton in its natural form. For instance, ordinary cotton will not take wool dyes, which produce several desirable effects not obtainable with the usual cotton dyes. This has been explained by the fact that cotton contains no nitrogen. Ways of adding nitrogen to cellulose have been known for many years, but recently we have developed a better way to convert cotton fiber into a nitrogenous substance. After an application of this treatment -- which we call aminization -- cotton goods can be dyed in warm, rich colors with wool dyes.

In addition, aminized fabrics dyed with some typical cotton dyes come out in darker shades and are faster to laundering than are untreated fabrics dyed with the same dye. Breaking strength of fabrics is unchanged by the treatment.

In our Laboratory in New Orleans, the new process of adding nitrogen has been applied to full width piece goods in lengths up to 100 yards. A patent on our process was issued to the Secretary of Agriculture in January.

Besides improving the dyeing properties of cotton, the introduction of nitrogen into cotton permits the addition of organic groups to give water repellency, rot resistance, or other new qualities needed for specific cotton uses. In other words, the development of a successful method of introducing nitrogen into cellulose greatly enlarges the scope of research to find new uses for cotton through chemical modification. As an example, we have found that aminized fabric can take traces of minerals out of water; and we expect to explore the possibility of using such fabrics in ion-exchange applications, as for instance in the purification of antibiotics.

Partial Acetylation

Another chemical modification that has opened up wide opportunities for cotton is the process known as partial acetylation, which is the best way we know to impart resistance to rot and mildew without impairing the original characteristics of the fiber. Treated textiles are colorless, odorless, and nontoxic. By this process part of the cellulose in cotton is transformed into cellulose acetate. The change is brought about by the addition of a simple substance, the acid of vinegar, to the basic unit of cellulose, which then becomes almost immune to rot and mildew and also has certain other desirable properties that are lacking in natural cotton.

The possibilities of partial acetylation as a means of increasing the utilization of cotton have been systematically investigated at the Southern Laboratory. Two manufacturers have applied the process to cotton bags, to be used in home water-softening systems. Other concerns are testing the process for use in making fish nets and shoe linings.

Partial acetylation also enhances the value of cotton for use in products such as ironing board covers that must be resistant to heat, and for several products where better resistance to electricity is needed. Because partially acetylated cotton has so many potentialities, we have undertaken to determine the exact extent of acetylation which gives the highest quality in each specific use.

Carboxymethylation

One property in which cotton already is superior to many other textile materials is absorbency -- the ability to take up large amounts of water quickly. This quality is what makes cotton so desirable for use in towels and similar products. We have found that the amount of water absorption can be increased approximately 20 percent by a chemical treatment called partial carboxymethylation. Here again, a simple substance is chemically combined with the basic cellulose unit. The optimum conditions for this treatment were established at the Southern Laboratory only last year.

The first towels produced under these conditions were recently tried out by a group of New Orleans' housewives, some of whom preferred them over ordinary towels even though the cloth used was not the most desirable for carboxymethylation. Another set of partially carboxymethylated towels using cloth of a more satisfactory weave is being prepared for testing. The treated towels not only absorb more water -- they dry at the same rate as ordinary towels.

Oxidation

During the last half century, a good many chemists have studied the effects of oxidizing agents on cellulose, but only recently have these investigations borne fruit. Today a process of oxidation is being applied commercially to the production of an important pharmaceutical product -- absorbable packing for use in surgery. The very instability which renders oxidized cellulose unsuitable for most purposes has made it excellent for this product. In 1943 Parke-Davis & Co, [4] began experimental production of sterile gauze and cotton for this purpose from oxidized cellulose provided by the Eastman Kodak Company. By 1945 clinical tests were so satisfactory that a plant with a capacity for producing up to 50,000 pounds of oxidized cellulose a year was designed and built by the Tennessee Eastman Corporation at Kingsport, Tennessee.

Today Johnson & Johnson, [4] as well as Parke-Davis & Co., [4] process the cellulose into surgical gauze and cotton.

Mercerization

Another long-known process is familiar to all of us. In fact, it is probably the best known example of improving cotton by means of chemical treatment. Nearly everybody knows that yarn or fabric which has been mercerized -- that is, treated with a concentrated solution of sodium hydroxide, then washed with water -- has greater strength, better luster, and better dyeing properties than unmercerized material. The chemist knows that the reason for this is that the sodium hydroxide has reacted in some way to bring about a chemical change in the cellulose.

Well known as this century-old process is, however, its potentialities have not been fully exploited, and the chemist continues to investigate it. At the Southern Laboratory, during World War II, we developed a modified mercerization process for the production of an all-cotton, semi-elastic bandage which surgeons considered superior for mild-pressure dressings. Recently, we were granted a patent on the application of a special mercerization process to give greater heat resistance to mechanical goods, such as beltings and tire cord.

Results of Modification and Other Research

In the short time available today, I have limited myself to examples of improvements that can be made in cotton for specific purposes simply by changing the structure of the basic unit of the cellulose. If time permitted, more examples of the modification of cellulose to produce new cotton products could be given. For instance, we have experimented with a number of methods for the introduction of phosphorus into the cellulose molecule, particularly for the purpose of improving flame-proofing qualities.

Neither will I have time to go into the other broad field where improvement of cotton fabrics is effected by the addition of chemicals which do not change the basic cellulose unit. Great advances have been made in our Laboratory in weather-proofing treatments to protect cotton fabrics for use in tents, tarpaulins, awnings, and tobacco shade cloth. We are making progress too in the development of self-sealing cotton fabrics for raincoats, tents, and similar uses. The objective is a fabric which will "breathe" when dry yet seal on wetting and stop the passage of water. There were interesting industrial developments in 1948 in the field of resin treatments to give muss-resistant cottons. Several companies will market crush-resistant summer wear made from treated cottons. Chemical and textile organizations are actively experimenting in this field and I am sure that further improvements can be expected.

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[4] The mention of this company does not imply endorsement by the Department of Agriculture of this company's products over those of other firms.

COTTONSEED

Now for just a few minutes I want to talk about cotton's other crop -- the seed -- which is so tremendously important as an industrial raw product. Obviously, any research which extends the market for cottonseed improves the economic position of the entire cotton crop.

Once more, the scientist is in the position of the old man who brought the donkey back to the village. He is faced with finding ways to improve the competitive position of a product by developing better methods of processing and by diversifying the outlets. The dominant place of cottonseed among oilseeds has been taken for granted too long.

The chemist and engineer have tackled this problem by a thorough study of storage and processing methods and by investigating the physical and chemical properties of the components of the seed.

Storage Investigations

Storage studies, at first conducted on a test-tube scale in our Laboratory and later extended to mill-scale tests in cooperation with commercial cotton oil mills here in Texas, as well as in other Gulf Coast states, have shown us that we can successfully prevent cottonseed from spoiling in storage by applying certain chemical treatments in combination with aeration of the seed.

We have tested more than 300 chemicals for this purpose and found that 45 of them, used in low concentrations, effectively inhibit deterioration. About 200 more chemicals will be tested before we complete this project.

Solvent Fractionation

In the field of cottonseed processing we have developed an entirely new method of solvent extraction. We call it fractionation -- because it separates the meats into three components -- oil, meal, and pigment glands. Our engineers at present are investigating the unit operations required to fractionate cottonseed in order to obtain the data needed to adapt the process to commercial feasibility.

The products produced by this method also are being intensively investigated. The oil compares favorably with cottonseed oil extracted by other methods. Feeding tests have shown that the meal -- which is almost white because practically all the pigment glands are separated in the fractionation process -- is far superior for many feeding uses to meal produced by conventional methods.

New Products from Pigment Glands

The pigment glands, never before isolated in quantity, may be the source of several entirely new products from cottonseed. The color of the pigments we have isolated varies -- some pigments are yellow, some are blue, and some are purple. We know there are other pigments in the glands. The yellow pigment is the one we call gossypol. It appears to have properties which make it suitable for certain pharmaceutical uses.

Conclusion

Perhaps you have observed that in the search for new uses for cottonseed, the chemist has applied exactly the opposite technique from that employed in cotton lint investigations. Whereas he started with the basic unit of cellulose as a building block and added chemicals to alter its characteristics for specific cotton products, in the case of cottonseed he has used his chemicals to partition the meats into basic fractions and then has investigated each of these fractions to determine its basic properties. He has carried this separation process still further. From the pigment glands he has isolated at least three chemical substances with distinct properties of their own.

Thus it would appear that the chemist is like the man who went up a stairway -- one step after the other -- until he reached the top, where he thought he would find a treasure. Instead, he found merely another stairway -- this time going down. The chemist, in research to improve the utilization of cotton and cottonseed, sometimes adds to an individual unit of the natural product, and sometimes breaks the intact natural product down into its own individual units. But always he has one aim -- to make the natural product more useful to industry and thus keep cotton and cottonseed ahead of their competitors.

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